

NAVAL HEALTH RESEARCH CENTER

A PHYSICAL TRAINING PROGRAM TO REDUCE MUSCULOSKELETAL INJURIES IN U. S. MARINE CORPS RECRUITS

VERSION 1.0

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**NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND
BETHESDA, MARYLAND**

**A PHYSICAL TRAINING PROGRAM TO REDUCE
MUSCULOSKELETAL INJURIES IN U.S. MARINE CORPS
RECRUITS**

USER'S MANUAL

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Summary

Problem.

Recruits at Marine Corps Recruit Depot (MCRD) San Diego are at risk for training-related musculoskeletal injuries due to their relatively low baseline fitness levels and the sudden increase in vigorous physical activity associated with boot camp training. The annual fiscal and operational costs of recruit musculoskeletal injuries at MCRD San Diego were estimated at \$16.5 million and 53,000 lost training days. Stress fractures were the single most costly injury, with an estimated annual cost in excess of \$5 million.

Objective.

The objective of this research was to evaluate the existing physical training schedule at MCRD San Diego and to make modifications that would reduce musculoskeletal injuries without negatively impacting the quality or mission of recruit training.

Approach.

Study Phases 1 and 2 included data collection to determine patterns of recruit musculoskeletal injuries and training-related physical activity. Two expert panels, with U.S. Marine Corps (USMC) and sports medicine representation, were then convened to evaluate the existing recruit physical training schedule. During Study Phase 3, the Naval Health Research Center's Sports Medicine and Research Team collaborated with the MCRD San Diego Recruit Training Regiment to develop a modified physical training program based on (a) scientific principles of exercise physiology, (b) research data from Study Phases 1 and 2, and (c) recommendations made by the expert panels.

Results.

The modified physical training schedule incorporated a balanced physical conditioning program including cardiovascular endurance, muscle strength and endurance, and flexibility training. The revised schedule targeted the average USMC recruit, who is in low to fair physical condition on arrival at MCRD, but it could be modified, depending on the baseline fitness level of each new class of recruits.

Conclusion.

We concluded that a needs-specific physical conditioning program, based on scientific principles and research data, could be developed to minimize exercise-related injuries in USMC recruits without negatively impacting the mission or fitness goals of recruit training.

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CHAPTER 1. BASIC PRINCIPLES OF PHYSICAL CONDITIONING

General Principles

- *Total Body Fitness:* Physical fitness refers to an individual's ability to efficiently perform both aerobic and strength-related activities and to that individual's ability to maintain such capacity throughout life. A physically fit person has cardiovascular endurance, anaerobic capacity, muscular strength and endurance, high lean body mass relative to body fat, and joint flexibility for optimal range of motion.
- *Balanced Training:* A balanced physical fitness program includes four major training elements: (a) aerobic (cardiovascular), (b) muscle strength and endurance, (c) flexibility, and (d) warm-up/cool-down. More advanced forms of conditioning *not* recommended for beginners due to the high injury potential include (a) anaerobic training (30- to 90-second bouts of high intensity exercise), (b) speed work (10- to 30- second sprints), and (c) power exercises (bursts of high-intensity muscle force).
- *Gradual Overload:* A conditioning program must gradually and progressively overload the cardiovascular and musculoskeletal systems to produce fitness gains. As a general rule, weekly training loads should not be increased more than 10% to 15%.
- *Specificity:* The training response is specific to the type of exercise used. For example, strength training produces predominantly strength gains with little effect on cardiovascular endurance. Likewise, the best way to improve running performance is to incorporate running into the training program. Therefore, training programs should include the four major elements of general physical conditioning along with sport- or mission-specific training.

- *Detraining:* Exercise must be continued on a regular basis to maintain fitness gains. Significant reductions in cardiovascular fitness occur within only 2 weeks of cessation of physical training. However, the amount of exercise required to maintain fitness is lower than that needed to improve fitness.
- *Injury Prevention:* Musculoskeletal injuries are the most common risks associated with routine exercise. Training variables and personal characteristics associated with increased injury rates include (a) higher weekly training volume (total amount of training, such as weekly running mileage), (b) abrupt increases in training volume or intensity, (c) improper exercise technique, (d) poor baseline fitness levels, (e) lack of prior exercise experience, and (f) prior musculoskeletal injury that has not fully recovered. General principles of injury prevention include: (a) gradual progression in training volume and intensity, particularly for the previously sedentary; (b) warm-up and cool-down sessions before and after all vigorous exercise; (c) proper exercise technique; (d) relative rest days after high-intensity cardiovascular or resistance training to allow adequate time for tissue recovery and adaptation; and (e) proper management of injuries.

Cardiovascular Conditioning

- The first step in any conditioning program is to build an aerobic base. This step requires 2 to 4 sessions per week of continuous aerobic activity, such as jogging or brisk walking, for 20 to 30 minutes at a moderate intensity. For most recruits, moderate intensity exercise will produce a heart rate of approximately 130 to 150 beats per minute and a perceived exertion of "moderately hard." Faster is not better. As long as the recruit gets his heart rate into the target range, running a given distance will produce approximately the same aerobic training effect and same caloric

expenditure, whether it is run at a 10 minute-mile pace or a 6 minute-mile pace. A minimum of 4 to 6 weeks is generally recommended for a healthy young adult to build an aerobic base.

- For beginning runners, a running frequency of greater than 3 sessions per week or a duration longer than 30 minutes per workout is associated with a significantly increased risk of musculoskeletal injuries. The gains in aerobic capacity with longer or more frequent running sessions are minimal relative to the increased injury risk.
- To minimize injury risks, only one running variable should be increased with consecutive training sessions. Running variables include distance per session, intensity (pace), weekly frequency, and difficulty of terrain. As a general rule, distance and frequency should be increased before intensity. High-intensity training, such as sprints, interval "fartleks", and "Indian runs," should be reserved for those individuals who have already built a firm aerobic base and a neuromuscular adaptation to running through several weeks of a regular jogging program.
- Modified interval training can be used to expand an individual's aerobic base and increase his capacity to run faster for longer periods of time. This training is performed by alternating 2- to 4-minute intervals of moderately low intensity running (40% to 60% of maximum effort and perceived exertion of "moderately easy") with 2- to 3-minute intervals of moderately high intensity running (70% to 80% of maximum effort and perceived exertion of "moderately hard") for 4 to 6 repetitions. This form of training will improve the recruits' average running speeds in preparation for the Physical Fitness Tests. To minimize injury risk, this type of training should be performed on nonconsecutive days and no more than 2 times per week.

- Cardiovascular fitness gains are lost very rapidly after the cessation of routine aerobic exercise. Significant reductions in aerobic capacity occur within 2 weeks, with many individuals returning to near baseline in just a few months. Although the minimal level of exercise required to maintain cardiovascular fitness is not known, studies suggest that as little as 15 to 20 minutes of aerobic exercise, performed 2 times per week, may be adequate as long as training intensity remains constant.

Muscle Conditioning

- Muscle conditioning consists of both muscle strength and endurance training. For general fitness, it should occur 2 to 3 times per week on nonconsecutive days for specific muscle groups. An exercise is considered primarily *strength* training if it produces temporary fatigue in the targeted muscle group within 60 to 90 seconds (generally, 6 to 10 repetitions at relatively high resistance). For muscle *endurance* training, multiple repetitions (more than 20) are performed using lower resistance. A gradual progression in the resistance used, and in the number of repetitions and sets performed, will maximize both safety and training benefits. For novice weightlifters, it is safer to begin with lower weights and higher repetitions. To start, most experts recommend 1 to 3 sets of 8 to 12 repetitions to temporary muscle fatigue.
- Studies have shown that 1 set of 8 to 12 repetitions, at a resistance high enough to produce temporary fatigue, performed 2 days a week will stimulate significant strength gains in the muscle group exercised. Although higher frequencies of training and more sets will produce a greater training response, the additional strength gains are usually relatively small. *Note:* A warm-up set of 15 to 20 repetitions at relatively low resistance should precede lifts involving large muscle groups (e.g., squats, bench press, leg press).

- Calisthenics are exercises that use body weight to produce resistance. They can be used for both muscle strength and endurance training. For the poorly fit recruit who can only perform a minimal number of repetitions, these exercises are primarily a form of *strength* training. For more fit recruits who can perform multiple repetitions, calisthenics are primarily a form of muscle *endurance* training.
- Resistance training is specific to the body part trained and to the range of motion through which the muscles are exercised. Strength gains occur only in the exercised muscles through the range of motion performed plus or minus an additional 10 to 20 degrees. For example, if an individual performs knee extension exercises through a range of 60 to 90 degrees, his knee extensors will become stronger within a range of motion of approximately 40 to 110 degrees. Therefore, all major muscle groups generally should be exercised through a full, *normal* range of motion. A few exceptions to this rule are discussed in the following paragraph. Extremes of motion should be avoided due to the increased injury risk.
- Exercise technique is important for both training effectiveness and injury prevention. All exercises should be performed in a *slow*, controlled manner. Some experts recommend at least 6 seconds per repetition. Proper body position will maximize training benefits and reduce injury risk. Low back pain and knee injuries are common exercise-related problems. Any exercises that result in (a) low back extension beyond 15 to 20 degrees or (b) full flexion at the waist with straight knees, place increased stress on the lower spine and should be avoided. Likewise, flexion of the knee beyond 90 degrees is not recommended since it significantly increases potentially damaging forces generated behind the patella (kneecap).
- “Super circuit training” combines muscle conditioning and cardiovascular exercises to produce both a strength and aerobic training stimulus. In a super circuit course,

resistance exercises are alternated with 30- to 60-second bouts of moderate intensity aerobic exercise with few to no rest periods. The resistance exercises can be performed using free weights, weight machines, or calisthenics. Examples of moderate intensity aerobic exercise include brisk walking, high stepping, and jogging. For maximum training effectiveness and safety, the resistance exercises should be sequenced such that (a) large muscle groups are exercised first and (b) consecutive exercises target different muscle groups. Since circuit training produces fewer aerobic fitness gains than continuous aerobic exercise, such as running, it should not be used as the only form of aerobic training.

- Cessation of resistance training will result in a progressive loss of muscular strength over a few months' time. Studies suggest that strength can be maintained with only one weightlifting session per week as long as intensity is maintained.

Flexibility Training

- Flexibility refers to joint range of motion. Limited flexibility is the result of tight muscles, tendons, and/or joint capsules. The resulting reduction in normal joint range of motion is believed to contribute to reduced performance and increased injuries. The purpose of flexibility training is to produce a permanent stretch in the muscles and connective tissues to allow full joint range of motion.
- Ideally, stretching exercises should occur before *and* after any strenuous physical training, as follows:

WARM-UP → stretch → exercise session → STRETCH

Since muscles are most flexible when they are warm, a 10- to 15-minute warm-up session should *always* precede any stretching exercises to minimize the risk of tearing tissues. Appropriate warm-up activities include brisk walking, slow jogging, and light calisthenics. The pre-exercise stretching should be activity-specific. For example, if the exercise session will include mostly running, the lower extremity muscles should be stretched. Flexibility training is most effective in producing longterm results when performed *after* the exercise session, when the muscles are the warmest.

- Flexibility is very joint-specific. Therefore, post-exercise stretching should target all major muscle groups. The recommended frequency is 3 to 5 times per week.
- For maximum safety and effectiveness, stretches should be (a) slow and static (no bouncing); (b) held for 10 to 20 seconds; (c) taken to the point of tightness, not pain; and (d) performed with proper biomechanical technique.

Warm-up and Cool-down

- The warm-up allows a gradual redistribution of blood flow to the muscles, preparing both the cardiovascular and musculoskeletal systems for the exercise session. The increased blood flow to the muscles produces a warming effect, increasing the elasticity of the muscles and connective tissues, which is believed to reduce injury risks. The warm-up should (a) last a minimum of 10 to 15 minutes, (b) use large muscle groups, and (c) gradually progress to the target activity. For example, 10 to 15 minutes of brisk walking, gradually increasing in pace, would be an appropriate warm-up for a running workout.
- The cool-down allows the body to gradually return to the resting state. The cool-down should (a) last a minimum of 10 to 15 minutes; (b) use the same large muscle

groups, in a similar activity pattern, as used in the preceding exercise session; (c) gradually decrease in intensity; and (d) finish with stretching exercises targeting all major muscle groups. An appropriate cool-down for a running workout would be a slow jog, gradually decreasing in pace to a brisk walk, followed by a total body flexibility routine.

CHAPTER 2. APPLICATION OF PHYSICAL CONDITIONING PRINCIPLES TO RECRUIT TRAINING AT MARINE CORPS RECRUIT DEPOT SAN DIEGO

Naval Health Research Center Data

The Naval Health Research Center (NHRC) has worked closely with the USMC since 1992 to reduce training-related musculoskeletal injuries in USMC recruits. NHRC studies conducted to date have determined the following¹:

Baseline Physical Fitness Level of Recruits on Training Day 1

- Less than 15% were in excellent physical condition.
- Greater than 30% were in poor to very poor condition.
- Less than 50% ran at least 3 times per week in the preceding 2 months.
- For those recruits who did run, the average run distance was less than 2.5 miles.

Note: Physical fitness levels were based on (a) each recruit's performance on the 1.5 mile run of the Initial Strength Test; and (b) each recruit's history of exercise in the 2 months prior to reporting to MCRD, as measured by questionnaire.

¹Shaffer, R.A., Brodine, S.K. & Corwin, C. et al. (1994). Impact of musculoskeletal injury due to rigorous physical activity during U.S. Marine Corps basic training. *Medicine and Science in Sports and Exercise*, 26, S141.

Musculoskeletal Injuries

- Thirty to 40% of recruits reported to a medical clinic with at least one musculoskeletal injury during the 11-week training cycle.
- Nearly 80% of the injuries were overuse injuries of the lower extremities, involving primarily the knee and ankle/foot regions. Overuse injuries are the result of gradually accumulated tissue microtrauma due to repetitive physical activities, like running or marching. Commonly diagnosed overuse injuries included iliotibial band syndrome, stress fractures, shin splints, patellar tendinitis, achilles tendinitis, and patellofemoral syndrome. The only two acute injuries that frequently occurred in recruits were ankle sprains and contusions (bruises).
- Most of the injuries occurred during training weeks that included high volumes of lower extremity impact activities, such as marching, running, and hiking. Injury rates were particularly high during the first 3 weeks of training when most recruits were unaccustomed to performing regular vigorous exercise.
- The annual fiscal and operational costs of training-related injuries at MCRD San Diego were estimated at \$16.5 million and 53,000 lost training days. Stress fractures were the single most costly injury, due to the associated long rehabilitation times and medical attritions.² Annual costs of stress fractures were estimated in excess of \$5 million.

² Naval Health Research Center (1993). Unpublished data.

Quantification of Training-Related Physical Activity

All physical activity in which recruits participated during the 11-week training cycle (for the then-current schedule, effective October 1994 to March 1995) was quantified to identify training factors that may have contributed to the high injury rates (see Tables 1 and 2). Table 1 summarizes the mileage moved by recruits during the activities that required running, walking, or marching over a distance. Table 2 presents the quantification, by number of sessions completed, of the remaining training-related physical activities.

Table 1

Physical Activity Performed by MCRD San Diego Recruits During 11-Week Training Cycle:
Mileage Moved by Activity and Training Phase (October 1994 to March 1995 Schedule)

Activity	1 st Phase (Weeks 1-3)	2 nd Phase (Weeks 4-7)	3 rd Phase (Weeks 8-11)	Total Mileage (11 weeks)
Incidental movement ^a	38.0	55.6	36.5	130.1
Running ^b	25.8	5.1	20.8	51.7
Marching ^c	46.5	0	28.7	75.2
Hikes ^d	0	23.0	0	23.0
Military training ^e	0	6.1	3.0	9.1
Total phase mileage	110.3	89.8 ^f	89.0	289.1

^a Incidental movement from training site to training site, performed as brisk walk, march, or jog.

^b Scheduled physical conditioning runs, performed in running shoes. Generally run in formation except for during fitness tests (7.5 miles total).

^c Estimate of actual miles marched during scheduled close order drill.

^d Load-bearing conditioning hikes; 3 hikes total (5, 8, 10 miles).

^e Various military training events, such as infiltration courses, combat formations, and the Marine Trail.

^f Greater than 50% of 2nd Phase miles performed carrying loads of 30 pounds or more.

Table 2

Physical Activity Performed by MCRD San Diego Recruits During 11-Week Training Cycle:
Number of Sessions of Water Survival Training, Strength Training, and Military Skills Training
(October 1994 to March 1995 Schedule)

Number of Sessions				
Activity	1 st Phase (Weeks 1-3)	2 nd Phase (Weeks 4-7)	3 rd Phase (Weeks 8-11)	Total (11 weeks)
Water survival training	1	0	3	4
Daily 7 calisthenics ^a	8	0	3	11
Circuit course ^a	4	0	1	5
Obstacle course ^a	2	0	1	3
Log drills ^a	0	0	1	1
Combat hitting ^b	3	0	0	3
Pugil sticks ^b	2	0	1	3
Bayonets ^b	1	0	1	2
Confidence course ^b	1	0	1	2
Rappelling ^b	0	0	1	1

^a General muscle strength and endurance exercises.

^b Military skills training.

Guidelines for Developing a USMC Recruit Physical Training Program

Two expert panels, with USMC and sports medicine representation (see Appendix A), were convened in December 1994 and March 1995 to evaluate the aerobic and muscle conditioning components, respectively, of the MCRD San Diego recruit physical training program. The overall goal of the panels was to make recommendations for revisions to the existing training schedule that would decrease musculoskeletal injuries without negatively impacting the quality or mission of the training program. USMC panel members included representatives from the MCRD G-3, Recruit Training Regiment, and Weapons and Field Training Battalion. Medical participants included experts in clinical sports medicine, exercise physiology, biomechanics, muscle strength and conditioning, and exercise research. The panel members received in-depth presentations on NHRC's recruit injury data and on the mission, goals, and specific elements of the MCRD San Diego recruit physical training program.

Expert Panel on Aerobic Training: Summary of Major Conclusions and Recommendations

- **Aerobic Training.** Aerobic fitness could be achieved with lower training loads than those prescribed during 1st Phase, especially given the relatively poor baseline fitness levels of most recruits. Recommendation: Develop a physical conditioning program that starts with moderate-intensity exercise and focuses on building an aerobic and muscular strength and endurance base.
- **Incidental Movement.** The incidental movement distances constituted a high training volume for the average recruit. If this movement were performed as brisk walking or marching for bouts of 10 or more continuous minutes, it

would produce a significant aerobic training stimulus in those recruits with low baseline fitness levels.

- **Total Mileage.** The more total mileage performed, including running, drill, hiking, and incidental movement, the higher the injury risk. Total run mileage and ramp-up of mileage was excessive in 1st Phase and in Week 10, especially given the high movement and drill miles. Recommendations: (a) Reduce initial run mileage to 1 mile or less; (b) ramp up run mileage more slowly during 1st and 3rd Phases; (c) schedule runs on nonconsecutive days to allow for tissue recovery; and (d) use aerobic training alternatives to running, such as swimming and continuous-movement circuit courses.
- **Formation Runs.** Stride length varies among recruits. Formation runs are more likely to cause injury than individual runs by forcing alterations in natural stride length and reducing biomechanical efficiency.
Recommendation: Reduce number of formation runs and increase number of individual runs.
- **2nd Phase Runs.** In the absence of running, neuromuscular adaptation to running declines over time. Inclusion of more running during 2nd Phase would better maintain running fitness. Recommendations: (a) Standardize the 2nd Phase beach run to 3.5 to 4.0 miles, and (b) add 1 to 2 short runs (1.5 miles) to Weeks 4 and 5.
- **Drill Technique.** An exaggerated heel strike while marching increases injury risk by distributing over the heel a force of up to five times the recruit's body weight. Recommendation: Prohibit the heel snap and knee jacking during drill.

- **Drill Evaluation.** Drill evaluation during 1st Phase promoted excessive, non-scheduled drill practice. Recommendations: (a) De-emphasize 1st Phase drill evaluation, and (b) limit lower extremity movement during drill performed during commander's time.
- **Hikes.** Load-bearing hikes produce multiple fitness benefits, including improvements in aerobic conditioning, muscular strength and endurance, and neuromuscular adaptation. Injury risk could be minimized by more gradual increases in mileage, loads, pace, and terrain inclines. Recommendations: (a) Ramp up hike mileage more slowly, (b) increase only one conditioning variable (e.g., distance, pace, load, terrain incline) at a time, (c) institute hikes during 1st Phase, and (d) optimize hiking routes to minimize the "downward" incline.
- **Drill Instructor Education.** Educating drill instructors in proper exercise techniques would maximize training effectiveness and minimize injury risks. Recommendation: Include expert instruction on physical conditioning and injury prevention in the drill instructor training curriculum.

Expert Panel on Muscular Strength and Endurance Training: Summary of Major Conclusions and Recommendations

The panel reviewed a videotape of recruits performing the "Daily 7" calisthenics, the circuit course, the obstacle course, and log drills. They also listened to a brief about "grass drills," a 2- to 3-minute series of several calisthenics performed in rapid succession. Grass drills were developed by Marines from the Recruit Training Regiment for implementation into the modified training schedule.

The panel made the following comments and recommendations:

- Daily 7 Calisthenics. An effective daily calisthenics program should condition all major muscle groups. The existing set of exercises over-emphasized upper body muscles and failed to target most lower body muscles. Some of the exercises used were considered obsolete and potentially unsafe.
Recommendations: (a) Incorporate the Daily 7 calisthenics routine developed by NHRC's Sports Medicine and Research Team (see Appendix B), (b) gradually increase the number of sets and repetitions of each exercise performed during the training cycle, and (c) ensure that recruits use proper technique.
- Circuit Course. The circuit course could be an excellent strength and conditioning tool. Ideally, it would be performed at least two times per week on nonconsecutive days. Since the greatest training stimulus occurs during the first set of repetitions, it is better to lengthen the time per exercise station than to increase the number of cycles through the course. A slow jog between stations would provide some aerobic conditioning in addition to the strength training. Many of the existing circuit course exercises could be modified to improve training benefits and reduce injury risks. Recommendations: (a) Increase the time per station to 45 to 60 seconds; (b) sequence stations such that large muscle groups are exercised first and consecutive exercises target different muscle groups; (c) ensure that exercises are performed in a slow, controlled manner; (d) ensure that recruits maintain a neutral spine position (no arching) while performing lifts, and when picking up or releasing barbells, to prevent low back injuries; (e) Step-ups Station: reduce step height to a maximum of 10 inches to decrease stress on the knees; slow the step cadence to 112 to 120 steps per minute to increase training effectiveness and reduce

injury risk; and ensure that entire sole of foot contacts the step; (f) Incline Sit-ups Station and Rowing Exercises Station: substitute abdominal crunches for full sit-ups to reduce stress to the lower back; (g) Hanging Leg Lifts Station: delete the straight-knee lift and use a bent-knee lift with a slow, deliberate extension of the knee to decrease stress to the lower back and hip flexors; and (h) Military Press Station: use a split stance (one foot forward) and a grip wider than shoulder-width to improve body mechanics.

- **Obstacle Course.** The obstacle course provided excellent strength and mission-specific training. The duration for one cycle, 3 to 5 minutes, was insufficient for any significant strength gains. Running in place between obstacles provided no added strength benefit and may have increased injury risk to the lower extremities. Recommendations: (a) Have recruits cycle through the obstacle course at least twice per session or perform it in conjunction with the circuit course, and (b) eliminate running in place between obstacles.
- **Log Drills.** Log drills were strengthening exercises in which telephone/utility poles were used for resistance. The exercises were performed in groups with approximately eight recruits per log. Exercises that required recruits to flex forward at the waist while holding the log placed excessive stress on the recruits' lower backs. The circuit course, obstacle course, and Daily 7 calisthenics were more effective and safer muscle conditioning techniques. Recommendation: Eliminate log drills from the training curriculum.
- **Grass Drills.** Grass drills could be an effective form of muscle conditioning if used properly. Exercises performed "as rapidly as possible" would likely

result in improper technique, reduced training benefit, and increased injuries.

Flutter kicks, bicycles, and leg spreaders (3 proposed calisthenics) place excessive stress on the lower back, particularly for the poorly fit recruit.

Recommendations: (a) Use only calisthenics known to be safe and effective (see Appendices B and C); and (b) ensure that all exercises are performed in a controlled manner, using proper technique.

- Flexibility Training. The physical training schedule did not include a comprehensive flexibility program. Regular stretching is believed to reduce injury risk and improve performance. Although stretching ideally should be performed before *and* after all strenuous exercise, it is most effective *following* an exercise session when the muscles are the warmest.

Recommendations: (a) Incorporate the total-body flexibility program developed by NHRC's Sports Medicine and Research Team (see Appendix D) into a cool-down routine to follow all strenuous physical activity, (b) perform stretching exercises after training requiring prolonged maintenance of certain body positions (e.g., weapons firing), and (c) precede any pre-exercise stretching with a 10- to 15-minute warm-up session (e.g., slow jog, Daily 7 calisthenics) to prevent muscle tearing.

CHAPTER 3. PHYSICAL TRAINING SCHEDULE MODIFICATIONS

NHRC's Sports Medicine and Research Team and the MCRD San Diego Recruit Training Regiment joined forces in January through March 1995 to develop a modified recruit physical training schedule. The revised program was based on (a) scientific principles of exercise physiology; (b) NHRC's research data on USMC recruit training-related injuries; and (c) the recommendations, presented in Chapter 2, made by the two expert panels on USMC recruit physical training. The modified schedule was implemented at MCRD San Diego in March 1995. This chapter summarizes the program revisions. Appendix E presents the modified physical training program in detailed schedule format.

The revised program targets the average U.S. Marine recruit, who is in low to fair physical condition on arrival at MCRD. However, the program can be modified depending on the baseline fitness levels and performances of each new platoon of recruits. For example, to challenge the more physically conditioned recruits, the runs can be performed in "ability groups" such that more fit individuals run at a faster pace. Likewise, the more fit recruits can perform more sets and repetitions of the calisthenics and circuit course exercises.

Summary of Modifications to the MCRD San Diego Recruit Physical Training Schedule

The modifications to the recruit physical conditioning program are summarized as follows:

1. a more progressive ramp-up of the running component in terms of distance, frequency, and intensity

2. fewer formation runs and more individual runs
3. addition of conditioning runs during 2nd Phase
4. decreased total running mileage and increased total muscle strength and endurance training for a more balanced conditioning program
5. modification of the Daily 7 calisthenics (see Appendix B) and the circuit course exercises to (a) target all major muscle groups, (b) enhance the strength training stimulus, and (c) reduce injury risk
6. implementation of a comprehensive flexibility training program (see Appendix D)
7. addition of exercise warm-up and cool-down routines
8. a more progressive ramp-up of load-bearing conditioning hikes
9. modification of the scheduling of different physical training events to maximize training benefit and minimize the risks of over-training and overuse injuries.

Tables 3 and 4 summarize the differences, in terms of volume of specific physical training events and types of training, between the modified recruit training schedule and the previously existing recruit training schedule (effective October 1994 to March 1995).

Table 3
Comparison of Volume of Specific Physical Training Events Between the Modified Recruit Training Schedule and the Prior Training Schedule

Training Event ^a	Prior Schedule (October 1994-March 1995)	Modified Schedule
Running (total mileage)	55 miles	33 miles
Individual runs	3	8
Formation runs	15	7
Rifle runs	0	1
Daily 7 calisthenics	11	16
Circuit courses	5	5
Obstacle courses	3	5
Grass drills	0	3
Log drills	1	0
Hikes	3 (5, 8, 10 miles)	4 (3, 4, 7, 10 miles)
1 st Phase Fitness Test run	3.0 miles	1.5 miles

^a Training volume measured in terms of the number of sessions unless otherwise stated.

Table 4

Comparison of Volume of Type of Physical Training Between the Modified Recruit Training Schedule and the Prior Recruit Training Schedule

Type of Physical Training	Prior Schedule (October 1994-March 1995)	Modified Schedule
Physical training days ^a	26	28
Run days ^b	18	14
Strength training days ^c	12	19

^aNumber of days with scheduled runs (including Marine Trail and Moto Run), circuit courses, obstacle courses, Daily 7 calisthenics, fitness tests, swimming, pugil sticks, or combat hitting.

^bNumber of days with scheduled runs (including Marine Trail and Moto Run).

^cNumber of days with scheduled Daily 7 calisthenics, circuit courses, or obstacle courses.

Modified Training Routines: Daily 7 Calisthenics, Warm-Up, Cool-Down, and Flexibility Training

Daily 7 Calisthenics

- The following list of Daily 7 exercises comprises a comprehensive calisthenics program that targets all major muscle groups. Appendix B provides a description and example of proper technique for each exercise.
 1. Side Straddle Hops (warm-up exercise)
 2. Wide Grip Push-ups (chest, shoulders)
 3. Crunches (abdomen)
 4. Hand-to-Knee Squats (hamstrings, quadriceps, gluteals)
 5. Standing Calf Raises (calf muscles)
 6. Standing Toe Raises (shin muscles)
 7. Back Extensions (lower back)
- The number of sets and repetitions of each exercise should be progressively increased (see Appendix E). Recruits should feel temporary muscle fatigue at the completion of each set of exercises.
- The Daily 7 can be used for warm-up exercises and for muscle strength and endurance training. For the recruit who can only perform 15 or fewer repetitions, the exercises are primarily a form of strength training. For the more fit recruits who can perform multiple repetitions, the exercises are primarily endurance training.

Warm-up Routine

The warm-up routine prepares the cardiovascular and musculoskeletal systems for the exercise session. It is believed to improve performance and reduce exercise-related cardiac and musculoskeletal injuries. If time allows, the warm-up can be followed by pre-exercise stretching. The warm-up should be performed as follows:

- Frequency: prior to any vigorous physical activity
- Intensity: low, increasing gradually to moderate
- Time: 10 to 15 minutes
- Type of Activity: movement of large muscle groups, particularly those that will be used during the exercise session
- Examples: (a) prior to a running event: slow jog for 0.5 to 0.75 mile, followed by lower extremity stretching; (b) prior to obstacle course: slow jog for 0.5 to 0.75 mile, or Daily 7, followed by upper extremity stretching.

Cool-Down Routine and Flexibility Training

The cool-down routine allows the body to gradually return to the resting state. It is also believed to enhance exercise performance and reduce the risks of cardiovascular and musculoskeletal injuries. The cool-down should be performed as follows:

- Frequency: following all vigorous physical activity

- Intensity: starting with an intensity near that of the scheduled training event and gradually decreasing to low intensity
- Time: 10 to 15 minutes (including stretching routine)
- Type of Activity: movement of large muscle groups in an activity pattern similar to that of the preceding exercise session, concluding with a total-body stretching routine
- Example: After a running event: run, gradually decreasing pace to a slow jog or brisk walk, then stretch
- Flexibility Exercises. The following set of stretching exercises targets all major muscle groups. All stretches should be (a) taken to a position of tightness, not pain; (b) performed in a static manner (no bouncing); and (c) held for 10 to 20 seconds. Appendix D provides a description and example of proper technique for each exercise.
 1. Forward Neck Flexion (posterior neck, upper back)
 2. Lateral Neck Flexion (lateral neck, shoulders)
 3. Lateral Neck Rotation (lateral neck)
 4. Rounded Shoulder Forward Reach (shoulders, upper back)
 5. Chest, Shoulder, Biceps Stretch
 6. Triceps Stretch
 7. Overhead Side Bends (trunk)
 8. Spinal Twist (lower back, iliotibial band)
 9. Groin Stretch

10. Kneeling or Standing Hip Flexor Stretch (hip flexors)
11. Supine Hamstring Stretch (hamstrings)
12. Prone Quadriceps Stretch (quadriceps, shin muscles)
13. Straight- and Bent-Knee Standing Calf Stretch

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Appendix A

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Appendix B

Daily 7 Exercises

DAILY 7

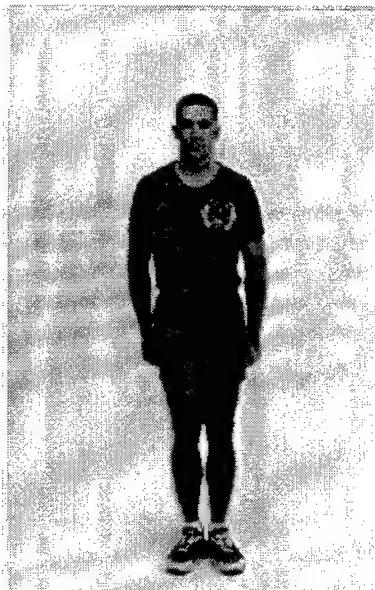


FIGURE 1A. Side Straddle Hops

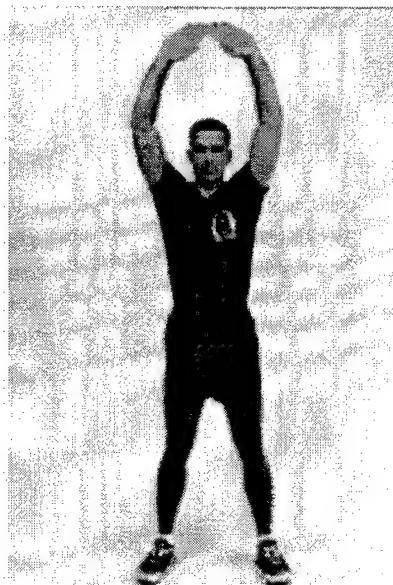


FIGURE 1B. Side Straddle Hops cont.

STARTING POSITION: Stand erect with feet together and hands placed at sides.

ACTION: Swing arms up and overhead, and spread feet apart in one movement. Return to starting position.

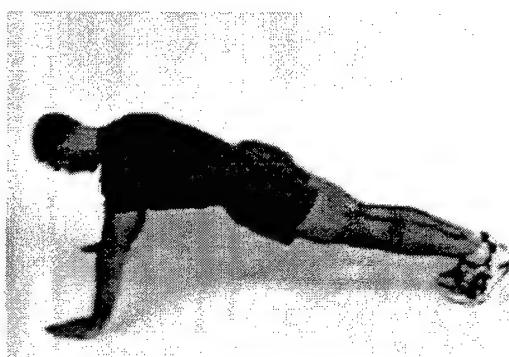


FIGURE 2A. Wide Grip Push-Ups



FIGURE 2B. Wide Grip Push-Ups cont.

STARTING POSITION: Place hands on deck, approximately shoulder-width apart, and extend legs. Keep head and neck in a neutral position.

ACTION: Lower body by bending arms until elbows reach a 90-degree angle. Return to starting position.

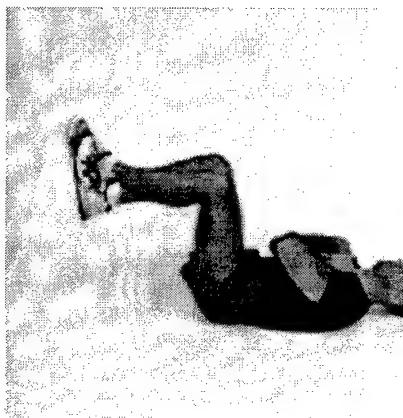


FIGURE 3A. Crunches

STARTING POSITION: Lie on back with knees bent at a 90-degree angle and hands placed across chest. Keep head and neck in a neutral position.

ACTION: Raise head and neck until shoulder blades come off the deck. Slowly return to starting position.

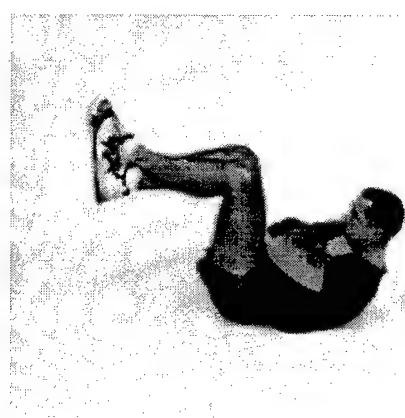


FIGURE 3B. Crunches cont.

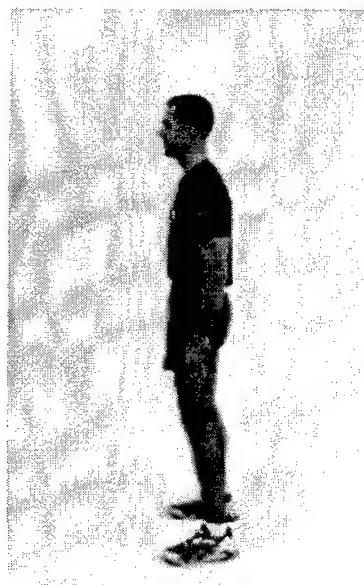


FIGURE 4A. Hand-To-Knee Squats

STARTING POSITION: Stand erect with head up, back flat, and feet placed shoulder-width apart. Place hands at sides.

ACTION: Lower body by bending knees until hands touch outside of knees. Return to starting position.

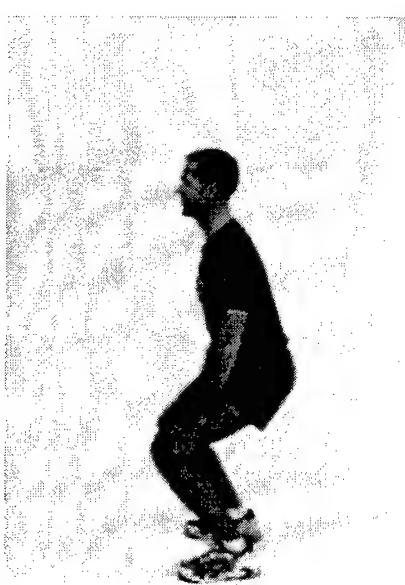


FIGURE 4B. Hand-To-Knee Squats cont.

Note: To increase the difficulty of this exercise, hold the squat position for 8 to 10 seconds.

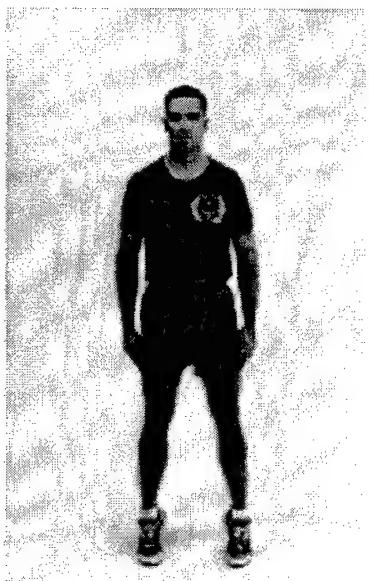


FIGURE 5. Standing Calf Raises

STARTING POSITION: Stand erect with feet placed approximately 8 inches apart. Place hands at sides.

ACTION: Raise up on toes, lifting heels off the deck. Return to starting position.

Note: To increase the difficulty of this exercise, hold the heel-raised position for 8 to 10 seconds.

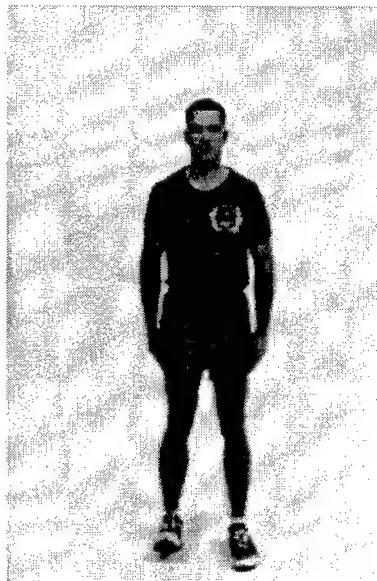


FIGURE 6. Standing Toe Raises

STARTING POSITION: Stand erect with feet placed approximately 8 inches apart. Place hands at sides.

ACTION: Alternately raise the toes of one foot. Return to starting position.

Note: To increase the difficulty of this exercise, hold the toe-raised position for 8 to 10 seconds.

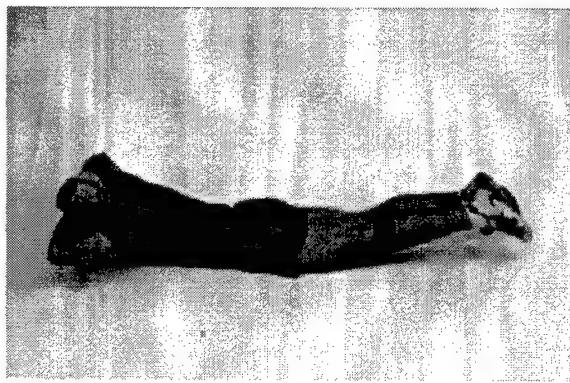


Figure 7. Back Extensions

STARTING POSITION: Lie on the deck, face down. Place hands on back of head with fingers interlaced.

ACTION: Raise head, chest, and feet 3 to 4 inches from the deck, tensing buttock and lower back muscles. Slowly return to starting position.

Note: To decrease the difficulty of this exercise, keep feet on the deck.

Appendix C

Additional Exercises for Grass Drills

ADDITIONAL EXERCISES -- GRASS DRILLS

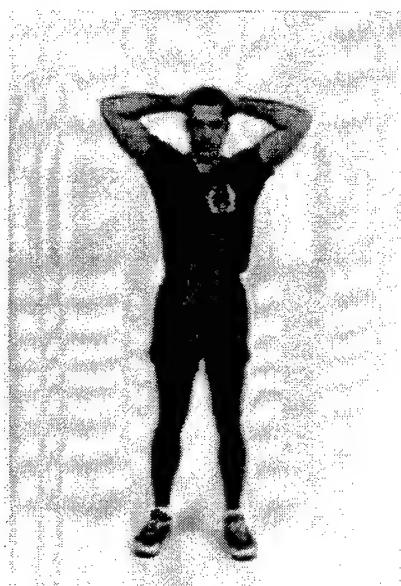


Figure 1A. Steam Engines

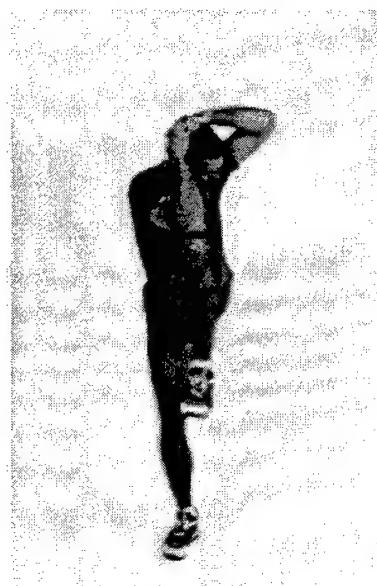


Figure 1B. Steam Engines cont.

STARTING POSITION: Stand erect with hands placed behind head and fingers interlaced.

ACTION: Bring right elbow to left knee by turning torso to the left and lifting left knee. Repeat on opposite side, bringing left elbow to right knee.

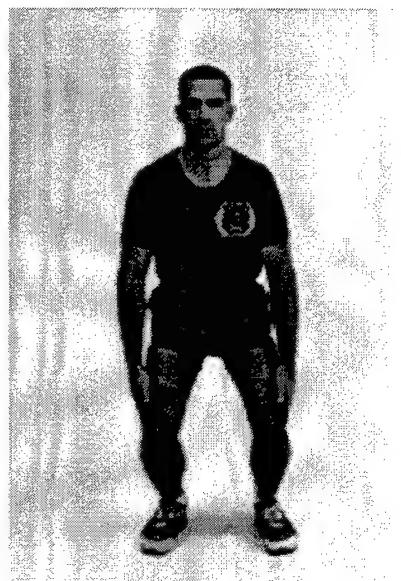


Figure 2A. Squat Jumpers



Figure 2B. Squat Jumpers cont.

STARTING POSITION: Stand with knees bent, back straight, and feet placed shoulder-width apart. Place hands at sides.

ACTION: Jump straight up, raising arms overhead and extending knees.

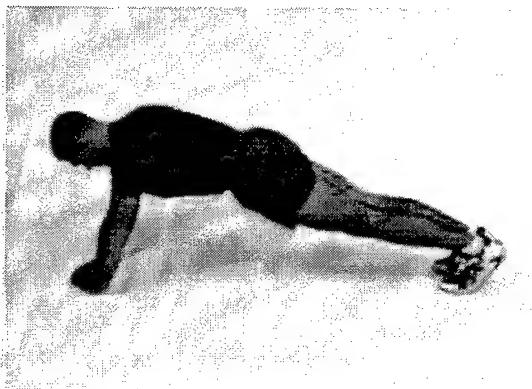


Figure 3A. Narrow Grip Push-Ups

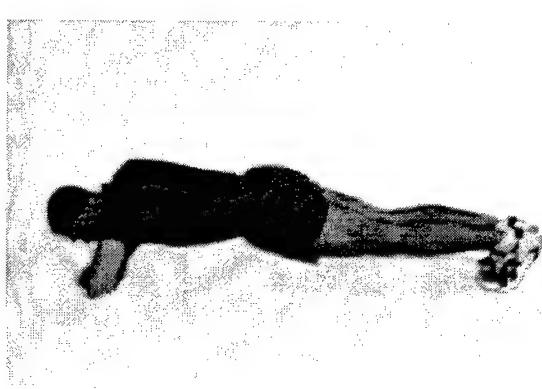


Figure 3B. Narrow Grip Push-Ups Cont.

STARTING POSITION: Place hands on deck forming a diamond shape with thumbs and forefingers. Extend legs. Keep head and neck in a neutral position.

ACTION: Lower body by bending arms until elbows reach a 90-degree angle. Return to starting position.

Appendix D

Flexibility Exercises

STRETCHING EXERCISES



Figure 1. Forward Neck Flexion

STARTING POSITION: Stand erect with feet approximately shoulder-width apart. Place hands behind back in an at-ease position.

ACTION: Flex neck forward, bringing chin to chest.

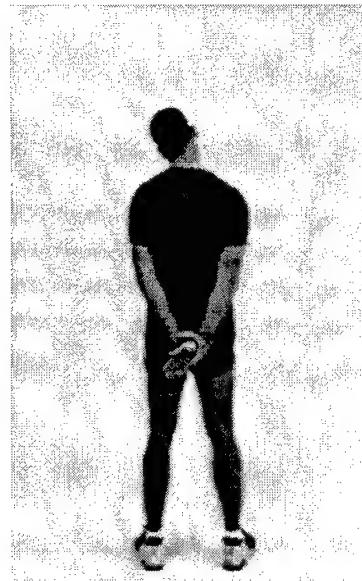


Figure 2. Lateral Neck Flexion

STARTING POSITION: Stand erect with feet approximately shoulder-width apart. Place hands behind back with left hand clasping right wrist.

ACTION: Flex neck to left, bringing left ear toward left shoulder. Gently pull right wrist toward the ground to increase the stretch. Return to starting position. Repeat on opposite side.



Figure 3. Lateral Neck Rotation

STARTING POSITION: Stand erect with feet approximately shoulder-width apart. Place hands behind back in an at-ease position.

ACTION: Rotate neck to right and look over right shoulder. Return to starting position. Repeat on opposite side.

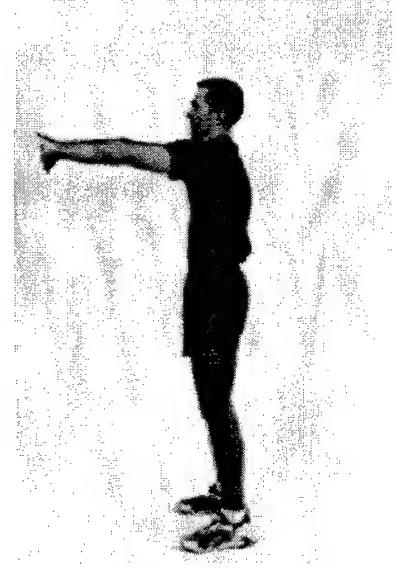


Figure 4. Rounded Shoulder Forward Reach

STARTING POSITION: Stand erect with fingers interlaced and palms turned outward.

ACTION: Extend arms outward and upward to shoulder level. Keep neck and shoulders in a relaxed position.

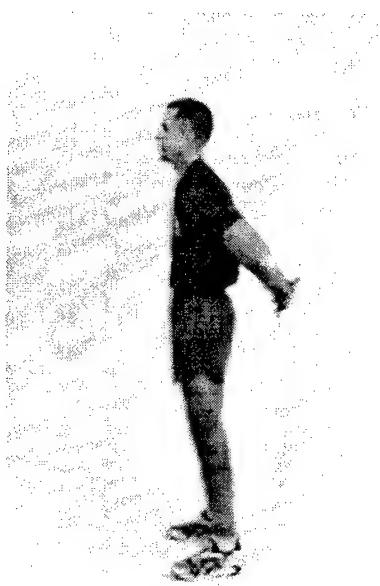


Figure 5. Chest, Shoulder, Biceps Stretch

STARTING POSITION: Stand erect with fingers interlaced behind back.

ACTION: Slowly straighten and lift arms, turning elbows inward.



Figure 6. Back Scratch Triceps Stretch

STARTING POSITION: Stand erect. Place arms overhead. Hold right elbow with left hand.

ACTION: Gently pull elbow behind head and hold. Return to starting position. Repeat on opposite side.



Figure 7A. Overhead Side Bends

STARTING POSITION: Stand erect with feet shoulder-width apart. Extend arms overhead. Grasp right wrist with left hand.

ACTION: Bend slowly to left side, using left arm to gently pull right arm over head and down toward ground. Return to starting position. Repeat on opposite side.



Figure 7B. Overhead Side Bends (Advanced)

STARTING POSITION: Stand erect. Extend arms overhead. Grasp right wrist with left hand. Cross right leg behind left leg.

ACTION: Bend slowly to left side, using left arm to gently pull right arm over head and down toward ground. Return to starting position. Repeat on opposite side.

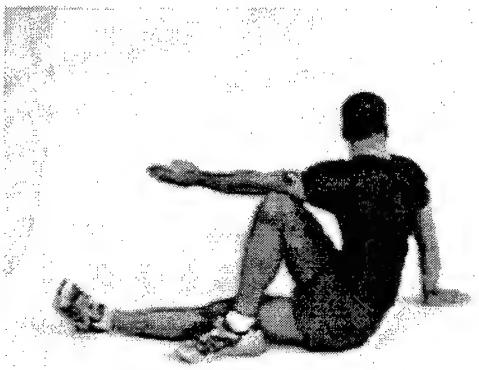


Figure 8. Spinal Twist

STARTING POSITION: Sit with left leg extended. Bend right knee and place right foot to outside of left knee.

ACTION: Use left elbow to apply pressure to right knee. Turn head and torso to right. Return to starting position. Repeat on opposite side.



Figure 9. Seated Groin Stretch

STARTING POSITION: Sit erect with soles of feet together. Grasp ankles.

ACTION: Use elbows to apply downward pressure to thighs. Keep back straight, and hold stretch. Return to starting position.

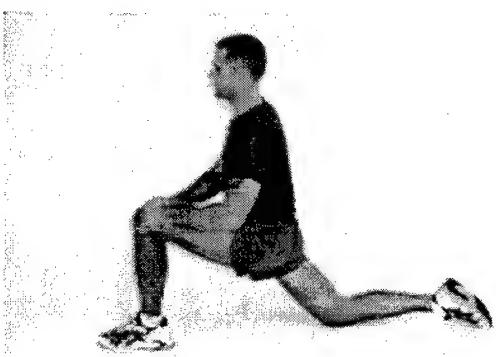


Figure 10A. Kneeling Hip Flexor Stretch

STARTING POSITION: Take a long step forward with left leg. Place right knee and top of right foot on deck. Place hands on left knee.

ACTION: Slowly tilt pelvis (hips and buttocks) under, contracting buttock muscles, until a stretch is felt in front portion of right hip. Return to starting position. Repeat on opposite side.



Figure 10B. Standing Hip Flexor Stretch

STARTING POSITION: Take a long step forward with left leg, making sure that left knee does not pass over left foot.

ACTION: Slowly tilt pelvis under, contracting buttock muscles, until a stretch is felt in front portion of right hip. Return to starting position. Repeat on opposite side.

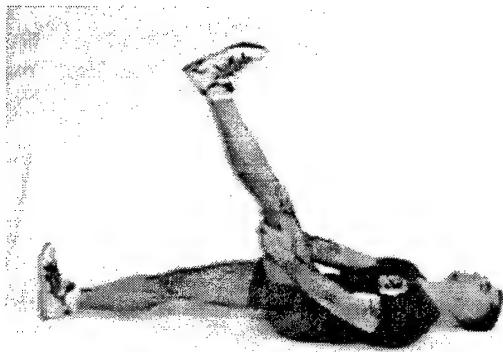


Figure 11. Supine Hamstrings Stretch

STARTING POSITION: Lie on back. Extend left leg up and grasp thigh. Point heel of left foot toward sky.

ACTION: Gently pull thigh toward chest and hold. Return to starting position. Repeat on opposite side.

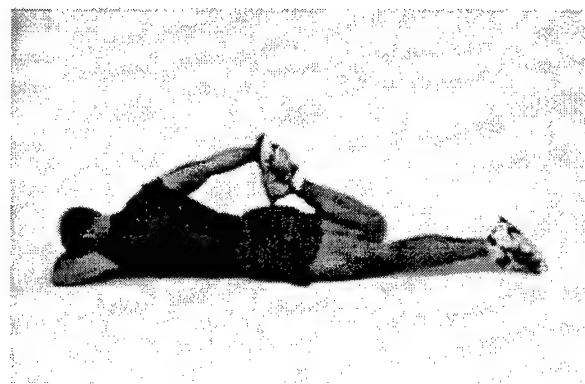


Figure 12. Prone Quadriceps Stretch

STARTING POSITION: Lie face down, resting head on left arm or hand. Take right hand and grasp right forefoot (not ankle or toes), bending knee.

ACTION: Gently pull foot straight back toward buttocks and hold. Return to starting position. Repeat on opposite side.



Figure 13A . Straight- and Bent-Knee Standing Calf Stretch

STARTING POSITION: Take long step forward with left leg, making sure that left knee does not pass over left foot. Keep toes of both feet pointing forward. Place hands on waist.

ACTION: Straighten right knee, keeping right heel on deck, and hold. In same position, slightly bend right knee and hold. Return to starting position. Repeat on opposite side.



Figure 13B. Straight- and Bent-Knee Standing Calf Stretch cont.

Appendix E

The Modified MCRD San Diego Recruit Physical Training Schedule

WEEK	MON	TUE	WED	THU	FRI	SAT
PROC	ARRIVAL	ARRIVAL	ARRIVAL	PROCESSING	PROCESSING	PROCESSING
1	F2 WARM-UP INITIAL STRENGTH TEST STRETCH	T1 WARM-UP INTRO TO PT DAILY 7 (REPS X 10) O'CRS DEMO ROPE CLIMB X 1 STRETCH	T2 WARM-UP DAILY 7 (REPS X 10) CIRCUIT CRS X 1 1.5-MI INDIV RUN STRETCH	T3 WARM-UP DAILY 7 (REPS X 10) ROPE CLIMB X 1 O'CRS X 1 STRETCH	T4 WARM-UP DAILY 7 (REPS X 10) 1.75-MI INDIV RUN PU/SU/PUSH-UPS X 1 STRETCH	T5 WARM-UP CHS I (2.5 HR) DAILY 7 (REPS X 10) CIRCUIT CRS X 1 STRETCH
2	T6 WARM-UP DAILY 7 (REPS X 15) 0.5-MI WARM-UP RUN, CIRCUIT CRS X 1 0.5-MI COOL-DOWN RUN PU/SU/PUSH-UPS X 2 STRETCH	T7	T8 WARM-UP CHS II (2.0 HR) DAILY 7 (REPS X 15) ROPE CLIMB X 1 O'CRS X 1 STRETCH	T9 WARM-UP GRASS DRILLS (20 SEC) 2-MI INDIV RUN STRETCH	T10 WARM-UP CHS III (2.0 HR) DAILY 7 (REPS X 15) CIRCUIT CRS X 1 STRETCH	T11 IWST (4.0 HR) 3.0-MI HIKE STRETCH
3	T12 WARM-UP BAYONET I (2.0 HR) DAILY 7 (REPS X 20) 2.5-MI INDIV RUN PU/SU X 1 STRETCH	T13 WARM-UP GRASS DRILLS (20 SEC) PUGIL STICKS I (2.0 HR) CONFID CRS (2.0 HR) STRETCH	T14	T15 WARM-UP INITIAL STRENGTH TEST STRETCH	T16 WARM-UP DAILY 7 (REPS X 20) O'CRS X 2 PUGIL STICKS II (2.0 HR) STRETCH	T17 INITIAL DRILL
4	T18 WARM-UP GRASS DRILLS (30 SEC) 1.5-MI FORMATION RUN STRETCH	T19	T20	T21	T22	T23 4.0-MI HIKE (4.0 HR) STRETCH
5	T24 WARM-UP DAILY 7 (REPS X 25) 1.5-MI RIFLE RUN STRETCH	T25	T26	T27	T28	T29 WARM-UP DAILY 7 (REPS X 25) 3.0-MI BEACH RUN STRETCH
6	T30	T31	T32	T33	T34	T35 7.0-MI HIKE (4.5 HR) STRETCH
7	T36	T37	T38	T39	T40	T41 10.0-MI HIKE (5.0 HR) STRETCH
8	T42 SWIM 1 (4.0 HR) STRETCH	T43 SWIM 2 (4.0 HR) STRETCH	T44 SWIM 3 (4.0 HR) STRETCH	T45	SERVICE WEEK	SERVICE WEEK
9	SERVICE WEEK	SERVICE WEEK	SERVICE WEEK	SERVICE WEEK	T46 WARM-UP DAILY 7 (REPS X 25) 2.5-MI INDIV RUN PU/SU X 2 STRETCH	T47 WARM-UP CONFID CRS (2.0 HR) STRETCH
10	T48 WARM-UP DAILY 7 (REPS X 25) BAYONET ASSAULT CRS PUGIL STICKS III (2.0 HR) STRETCH	T49 WARM-UP DAILY 7 (REPS X 25) O'CRS X 1 CIRCUIT CRS X 2 STRETCH	T50 WARM-UP DAILY 7 (REPS X 25) 3.0-MI FORMATION RUN PU/SU X 2 STRETCH	T51 WARM-UP RAPPELLING (4.0 HR) STRETCH	T52 WARM-UP FINAL PFT STRETCH	T53 WARM-UP MARINE TRAIL STRETCH
11	T54 FINAL DRILL	T55 BN CMDRS INSPECTION	T56	T57 WARM-UP 4.0-MI MOTO RUN STRETCH	GRADUATION	

**MODIFIED MCRD SAN DIEGO RECRUIT PHYSICAL TRAINING SCHEDULE,
EFFECTIVE MARCH 1995**

Bayonet = bayonet skills training.

Beach Run = a physical conditioning run, performed in formation on beach sand, in running shoes and gym clothing.

CHS = combat hitting skills training.

Circuit Crs x n = circuit course and number of times performed.

Confid Crs = confidence course, a series of physically and psychologically challenging events and obstacles.

Daily 7 (reps x n) = Daily 7 calisthenics and number of repetitions of each exercise.

Formation Run = a physical conditioning run, performed in a close group, in running shoes and gym clothing.

Grass Drills = a series of calisthenics performed in rapid succession without rest.

Hike = a load-bearing conditioning march/hike.

Indiv Run = an individual (vs. formation) physical conditioning run, in running shoes and gym clothing.

Initial Strength Test = a field fitness test consisting of (a) a maximum-effort 1.5-mile run, (b) maximum number of sit-ups in 2 minutes, and (c) maximum number of pull-ups.

IWST = Initial Water Survival Training.

Marine Trail = a 4.0-mile load-bearing run, including a number of physical challenges, performed in boots and utilities.

MI = miles.

Moto Run = a formation run, in running shoes and gym clothing.

PFT = a field fitness test consisting of (a) a maximum-effort 3.0-mile run, (b) maximum number of sit-ups in 2 minutes, and (c) maximum number of pull-ups.

PU/SU/Push-ups x n = pull-ups/sit-ups/push-ups and number of sets of each exercise.

O'crs x n = obstacle course and number of times performed.

Rifle Run = a formation run, performed in boots and utilities, with rifles.

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13. ABSTRACT (Maximum 200 words) Recruits at the Marine Corps Recruit Depot (MCRD) San Diego are at risk for training-related musculoskeletal injuries due to the sudden increase in physical activity associated with boot camp. The annual fiscal and operational costs of these injuries were estimated at \$16.5 million and 53,000 lost training days. The objective of this research was to evaluate the physical training schedule at MCRD and to make modifications that would minimize musculoskeletal injuries without negatively impacting the mission of recruit training. Study Phases 1 and 2 included data collection to determine patterns of recruit musculoskeletal injuries and training-related physical activity. Two expert panels, with U.S. Marine Corps (USMC) and sports medicine representation, were then convened to evaluate the existing recruit physical training schedule. A modified physical training program, based on (a) scientific principles of exercise physiology, (b) research data from Study Phases 1 and 2, and (c) recommendations made by the expert panels, was jointly developed by the Naval Health Research Center and the MCRD San Diego Recruit Training Regiment. We concluded that a needs-specific physical conditioning program, based on scientific principles and research data, could be developed to minimize exercise-related injuries in USMC recruits without negatively impacting the mission or fitness goals of recruit training.			
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